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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

REPLY TO ATTN OF: GP

July 6, 1971

MEMORANDUM

TO: KSI/Scientific & Technical Information Division
Attn: Miss Winnie M. Morgan

FROM: GP/Office of Assistant General Counsel for Patent Matters

SUBJECT: Announcement of NASA-Owned U.S. Patents in STAR

In accordance with the procedures contained in the Code GP to Code USI memorandum on this subject, dated June 8, 1970, the attached NASA-owned U.S. patent is being forwarded for abstracting and announcement in NASA STAR.

The following information is provided:

U.S. Patent No. : 3,299,431

Corporate Source : Keltec Industries, Inc.

Supplementary Corporate Source :

NASA Patent Case No.: HQN-00937

Gayle Parker

Enclosure:
Copy of Patent

Jan. 17, 1967 L. E. HOBLIN 3,299,431

UNFURLABLE STRUCTURE INCLUDING COILED STRIPS
THRUST LAUNCHED UPON TENSION RELEASE
Filed Feb. 10, 1964

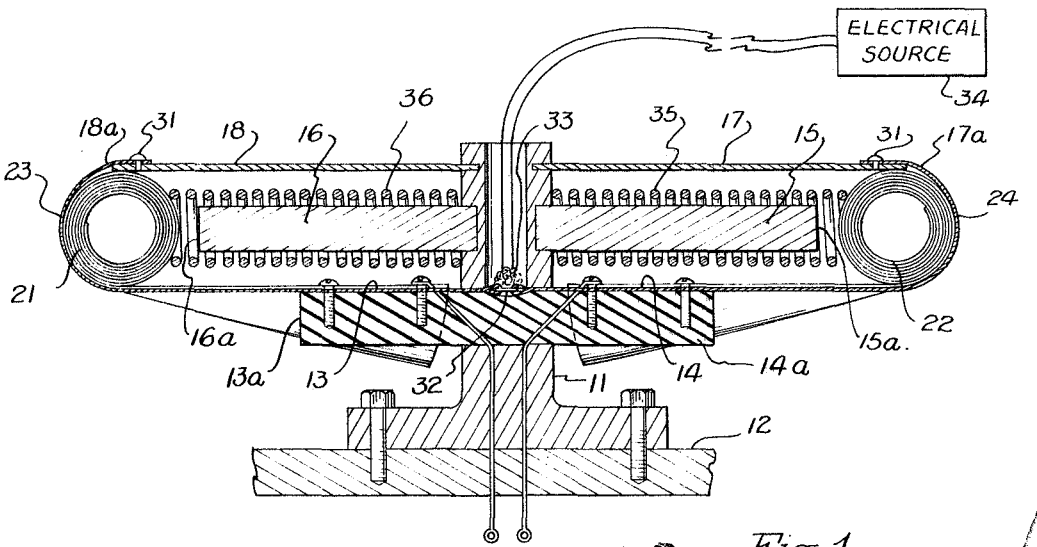

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Fig. 1

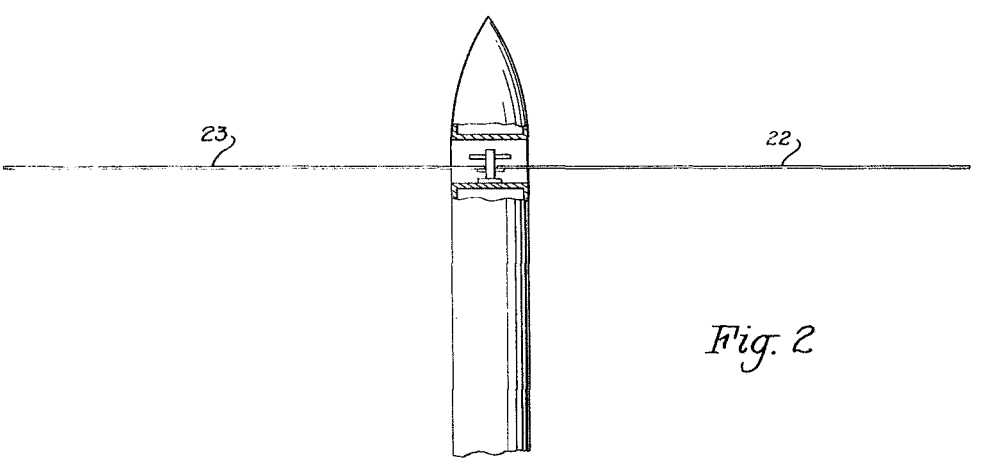

Fig. 2

INVENTOR

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AGENT

United States Patent Office 3,299,431 Patented Jan. 17, 1967

3,299,431

UNFURLABLE STRUCTURE INCLUDING COILED STRIPS THRUST LAUNCHED UPON TENSION RELEASE

Lester E. Hoblin, Fairfax County, Va., granted to National Aeronautics and Space Administration under the provisions of 42 U.S.C. 2457(d)

Filed Feb. 10, 1964, Ser. No. 343,760
8 Claims. (Cl. 343—823)

This invention relates in general to antennas of the whip variety and in particular to extensible whip antennas.

Since the introduction of unfurlable whip antennas by R. B. Blackmore, to whom U.S. Patent No. 2,157,278 was granted on May 9, 1939, many have endeavoured to perfect a metallic strip sufficiently resilient to permit extensive deformation of the strip over extended periods of time without deterioration of the resilient properties thereof. Now that a metallic strip having such resilient properties is available, unfurlable whip antennas have been recognized as practical mechanical structures and considerable effort has been expended to devise means for transposing the deformation and the extension.

In many extensible antenna applications, particularly in spacecraft applications, weight, size and power requirements are especially critical. Often environmental factors must be controlled in such applications, and it may be necessary, for example, to employ nonmagnetic materials exclusively. Moreover, it is generally essential that the structure afford a significant rigidity and durability in its extended state. Most prior art devices which require both extension and retraction anchor the deform reel in the manner disclosed by Blackmore, and the metal strip is extended and retracted by rotation of the reel, usually by means of an electrical motor system. In the case of an extension without retraction, either end may be anchored, of course, and one prior are device anchors the deform unit, a hollow cylinder wherein the furled metallic element is stored and employs a sideways ejection such that the fully extended antenna is pivoted into final position. Another more complex prior art device anchors the free end of each of two metallic elements which are spun upon ejection and the deform unit, a unique reel with conical side cheeks is adapted to serve as a centrifugal brake acting differentially to control the rate of ejection.

Each of these prior art extensible antenna ejection devices has found some utility in selected applications but few, if any, devices of this variety meet the demands of outer space. In particular, it has been found that the pivot features of one prior art device often presents an electrical and a mechanical problem in reliability. Also, the unique reel assembly, necessary to the free extension unit described above, introduces a weight complication which precludes its application in many instances.

It will be appreciated that a lightweight, reliable extensible antenna is needed and would be welcomed as a significant advancement of the art. Accordingly:

It is an object of this invention to provide an extensible dipole antenna which is relatively lightweight.

It is another object of this invention to provide an extensible dipole antenna in which the ejection means may be of nonmagnetic material.

It is also an object of this invention to provide an extensible dipole antenna wherein no readjustment of element orientation is required upon full extension of the antenna.

It is a further object of this invention to provide an extensible dipole antenna with a rigid fixed electrical connection upon extension.

It is still another object of this invention to provide an extensible dipole antenna wherein a positive ejection of the antenna elements is assured.

Other objects of the invention will become apparent upon a more comprehensive understanding of the invention for which reference is had to the following specification and drawings wherein:

FIGURE 1 is a detailed showing of one embodiment of this invention in readiness for unfurlment.

FIGURE 2 is a showing of the embodiment of FIGURE 1 in its unfurled state.

Briefly, the device of this invention is an extensible dipole antenna employing a naturally tubular metallic strip element which is deformable into a transverse coil form and is sufficiently resilient to revert back to its natural configuration. The device affords a positive action ejection of the strip element in coil form by release of a loaded compression spring means whereby the resilience of the strip is implemented.

Referring now to the drawings,

The embodiment of this invention shown in FIGURE 1 includes a base and center column section **11** which is secured by conventional means to the support member **12** which may be, for example, the spear boom of a missile intended for satellite application.

In accordance with the invention, at least three pairs of transverse members, the pair **13** and **14**, the pair **15** and **16**, and the pair **17** and **18**, having end sections, **13***a* and **14***a*, **15***a* and **16***a*, **17***a* and **18***a*, respectively, are disposed in parallel relation to substantially define a plane and are attached to the center column section **11** such that the end sections of each pair are substantially equidistant the center column section **11** and each member is in substantially perpendicular relation with respect thereto. It will be appreciated, of course, that in the depicted embodiment the pairs of members, **15** and **16**, and **17** and **18**, may in actuality be a single continuous member of conductive or nonconductive material which passes through the center column section. The pairs of members **13** and **14**, however, are connected to the dipole elements **21** and **22** which, of course, must be electrically isolated. Consequently, if a single continuous member is to be substituted for the pair **13** and **14**, the member must be of a nonconductive material.

As shown in the embodiment of FIGURE 1, the pair of members **15** and **16** may be longer than the pair of members **13** and **14**, and the pair of members **17** and **18** may be longer than the pair of members **15** and **16**. In this length relationship, the coiled dipole elements **21** and **22** may be nested slightly beneath the respective member of pair **17** and **18** and substantially adjacent the respective end section of pair **15** and **16** by detent means **23** and **24**, respectively.

It will be appreciated that various forms of detent means may be employed with the device of this invention to contain the dipole element in coiled form. In the illustrative embodiment, each detent means comprises a string section secured at one end as indicated at **31** to the respective end sections **17***a* and **18***a* with the other end tied to an interrupter means **32** such that upon interruption the string section no longer restrains the coiled dipole element, and it is free to unfurl.

In this embodiment, the interrupter means **32** comprises a link of fuseable wool **33** in contiguous relation with the fuseable wire. Firing means **34** may be an electrical source, as shown, which effectively ignites the wool to separate the loop and thus disable the detent means **23** and **24** simultaneously upon the activation of switch means **34** by remote control means, not shown.

In accordance with the invention compression springs **35** and **36** are disposed about the transverse members **15** and **16**, respectively. Since the no load length of each of the springs **35** and **36** is substantially greater than the length of its respective transverse member, it will be seen

that with the coiled dipole element in readiness as shown, the springs **35** and **36** are under considerable tension. Thus, when the detent means **23** and **24** are disabled, the force of the springs **35** and **36** ejects the coiled dipole elements simultaneously.

The coiled dipole elements **21** and **22** are electrically and mechanically secured at their free end to respective members of the pair of transverse members **13** and **14**. As in the device described by Blackmore in his aforementioned patent, the metallic strips, which form each of the dipole elements **21** and **22**, have a natural circular cross-section with a substantial overlap. In addition, these metallic strips are characterized by a high resiliency which permits nonpermanent deformation into coil form. This type of material is generally of the alloy variety and may be formed by various manufacturing techniques generally including heat treatment at one or more stages.

FIGURE 2 is illustrative of the device of FIGURE 1 after the detent means has been disabled and the elements **21** and **22** have been unfurled. In this illustration, the unfurlable antenna device is disposed in the nose end of a rocket or other space vehicle and the elements **21** and **22** are extended in substantially perpendicular relation to the general axis of the vehicle. It will be noted that the compression spring means are missing in the embodiment depicted in FIGURE 2. These ejection means may be ejected in the course of the coiled member release or otherwise. It is, of course, within the purview of this disclosure to employ suitable detaining means, not shown, in the event release of the ejection means would be undesirable. Further, in this illustration the elements **21** and **22** and the central support member to which they are attached are shown without electrical insulation means therebetween. It will be appreciated that some electrical separation is essential to most applications of the device of this invention and that this may be accomplished as shown in the embodiment of FIGURE 1 or otherwise.

The dipole elements **21** and **22** may be coiled either in the direction relative to the natural circular cross-section shown in the drawing or in the opposite direction, provided, of course, the strip material has sufficient resiliency. It has been found, however, that coiling in the direction shown in the drawing is to be preferred in most applications.

It will be appreciated that the depicted compression spring means for initial ejection of the coiled elements **21** and **22** is not essential to the operation of the device and that various other spring loaded means for ejection secured by the detent means shown or by other suitable means, for example, a cooperative latching mechanism, are within the purview of this disclosure.

Likewise, it is not essential that the detent means be released by remote control. In the event direct control means are employed, it will be appreciated that a wide variety of means may be employed to release the detent means.

Furthermore, it is not essential to this invention that two members be released or that the release of members occurs simultaneously. Thus it is within the purview of this disclosure to employ a separate detent means for each coiled member and to cause the release of members in any selected order, if desired.

Moreover, the device of this invention is not restricted to extensible antennas nor to electrical applications in general, and the unique concept embodied therein is applicable to a wide variety of uses including decorative display systems, direction indicator means and the like.

Finally, this invention is to be limited only by the scope of the claims appended hereto.

What is claimed is:

1. An unfurlable structure comprising a central support member, a plurality of ribbon like flexible strip elements each having a coiled portion and a free end portion disposed with the free end thereof directed toward said central support member; a like plurality of rod means extended from said central support member in selected directions; means for attaching said free end of each of said strip elements to a respective rod means in said plurality thereof such that the axis of each coiled portion and its respective rod means are in a transverse relation; each of said elements having a selected length and width and characterized by a stable circular cross-section with a substantial overlap and by a resiliency such that said stable circular cross-section may be readily restored subsequent to deformation of said strip element into coil form; detent means adapted to maintain said coiled portion of said elements at a selected distance from said central support member; tension loaded ejection means interposed said coiled portion of each of said strip elements and said central support member and adapted to provide a thrust force therebetween upon tension release; and detent release means adapted to free said coiled portion of said strip element such that said tension release occurs.

2. An unfurlable structure as defined in claim **1** wherein said flexible strip elements are adapted as antenna elements.

3. An unfurlable structure as defined in claim **2** wherein said plurality of flexible strip elements is an even number plurality, said strip elements are paired and each pair is disposed in opposite relation about said central support member and said detent release means are adapted to release respective elements of each of said pairs thereof in time coincidence such that said thrust force of respective ejection means directed toward said central support means is substantially counter-balanced.

4. An unfurlable structure as defined in claim **2** wherein at least a portion of said tension loaded ejection means are compression spring means and said detent means are adapted to maintain said spring means under compression.

5. An unfurlable structure as defined in claim **3** wherein at least a portion of said tension loaded ejection means are compression spring means and said detent means are adapted to maintain said spring means under compression.

6. An unfurlable structure as defined in claim **5** wherein said detent means are strap means.

7. An unfurlable structure as defined in claim **6** wherein respective strap means of respective strip elements in each pair thereof are interlinked and said detent release means is operative to interrupt the linking therebetween.

8. An unfurlable structure as defined in claim **7** wherein said detent release means is a fuseable material in close proximity to said strap means of respective strip elements in each pair such that ignition of said fuseable material affords interruption of said linking therebetween.

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